Canon

Printer Class Specification / Protocol for IEEE-1394

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NOTE : The contents of areas shaded in this format are TBD.

TABLE OF CONTENTS

1. INTRODUCTION

1.1 SCOPE

This document will describe the 1394 Printer Class Protocol Specification which should apply to all printers that connect to the IEEE1394 High Performance Serial Bus. The specification will provide a flexible method for any printers to comply to.
The specification will cover printers such as:

PDL printers
Multifunction devices
Video printers
Bit image printers
Plotters
etc.

The specification is defined so that any printer will be categorized into one of the sub-groups of the specification.

1.2 PURPOSE

This purpose of this protocol specification is to define configuration and functional sequences for 1394 printing devices that will connect directly to personal computers as well as consumer devices and computer peripherals. What will be described is;

- A sequence for various host devices to establish connection to, and get basic status of a printer on a IEEE1394 serial bus.
- A method for multiple host devices to share a printer on a IEEE1394 serial bus.
- A method for multiple printers with various transport protocols, printing protocols, and data types to reside.
- A simple printing protocol that enables peer to peer printing from various image devices.

1.3 REFERENCES

- IEEE Std. 1394-1995, Standard for a High Performance Serial Bus
- 1394-based Digital Camera Specification Version 1.04 August 9,1996
- AV/C Digital Interface Command Set Version 1.0 September 13,1996

2. IEEE1394 CAPABILITY

2.1 CABLE PHYSICAL LAYER

All cable physical layer implementations compliant with this standard shall meet the performance criteria specified in the IEEE 1394 standard. In addition to the cable/connector defined in IEEE 1394 standard, the 4 pin AV Cable/Connector defined may be used for group B printers..

2.2 LINK LAYER

All link layer implementations compliant with this standard shall meet the performance criteria specified in the IEEE 1394 standard.

2.3 TRANSACTION LAYER

All transaction layer implementations compliant with this standard shall meet the performance criteria specified in the IEEE 1394 standard.

3. DEFINITIONS

3.1 LOGIN PROTOCOL

This specification will describe a simple printer connection sequence defined as a

Login Protocol

The purpose of this protocol is to present a common printer-connection process which will at least include following requests to the printer ; locking on to the printer, inquiring current lock status and transfer protocol in use (if locked.), inquiring transfer protocol type capabilities, and enabling 1 transfer protocol to be used from then on. As noted, the 1394 printer will act as the target in this process; the host device wishing to connect should initiate the login sequence. It will also provide connection-less printer status retrieval means.

3.3 DIRECT-PRINTING (DIRECT-PRINT PROTOCOL)

In this specification,

"Direct-printing"

will be defined as a printing process which will follow the Login Protocol noted above, and the

Direct-Print Protocol(DPP)

which will be explained in this specification. The Direct-Print Protocol will define printer control request commands and functions as well as print data format. Details will be explained later on.

Naturally, host devices that will use the Direct-Print capabilities of the printer must be able to execute the Direct-Print Protocol.

3.3 RELATIONSHIP BETWEEN LOGIN AND DIRECT-PRINT PROTOCOLS

The diagram below describes the relationship of the 2 protocols.

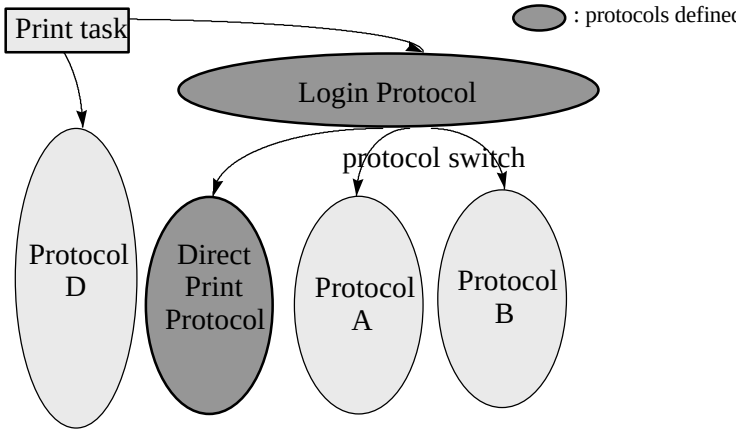


fig. 3.1

3.4 PRINTER CATEGORY

The 1394-based printer can be defined in the following manner by it's connection and printing capability.

Group A : "Login Protocol" Capable Printer

Printers that are capable of the login protocol, but do not support Direct-Printing Protocol are grouped as **Group A printers**. Printers in this group cannot be logged on and printed unless hosts comply with the login process explained. These printers use various existing transport protocols and Page Description Languages as well as device-specific protocols.

Printers that support printing protocols other than Direct- Print Protocol, such as PC based printers are assumed for this group

Group B :"Direct-Print" Capable Printer

Printers that are capable of the login protocol and support the Direct-Print protocol are grouped as **class B printers**. Printers in this group cannot be logged on and printed unless hosts comply with the login process explained. These printers can use the Direct-Print Protocol defined in this specification to handle print jobs.

Printers that can be directly connected to "Direct-Print" compliant consumer devices (A future "Direct-Print" compliant Camcorder may be an example.) are assumed for this group

Candidate hosts for Direct-Print capability include computer peripherals such as Image scanners, Digital cameras , and consumer electronic devices such as video camcorders, TVs, and set-top boxes etc.

Group C :Non-"Direct-Print" Capable Printer

Printers that are NOT capable of the login protocol are grouped as **class C printers**. Printers categorized in this group do not follow the login protocol described, and most of the communicating sequence with the host is device-specific.

Printers directly connected to Non-"Direct-Print" compliant consumer devices (existing 1394 Camcorders, Communication cameras) are assumed for this group

The next table will show the requirements for the different printer groups.

Table 3.1

	Login Protocol	Direct-Print Protocol	Plug and Play[*1]	Power Management[*2]
Group A	mandatory	not implemented	mandatory	mandatory
Group B	mandatory	mandatory	optional	optional
Group C	not implemented	not implemented	not implemented	not implemented

*1 : Plug and play is under study and is TBD.
*2 : PowerManagement is under study and is TBD.

4. OVERVIEW

Group A : “Login Protocol” Capable Printer

For group A printers, **this proposal will not define a specific Transport Protocol,** but will define an interface that is capable of supporting existing protocols such as IEEE1284.4, SBP-2 as well as vendor-specific protocols. The choice of protocol (s) used will be left for the printer manufacture to decide.

A host connecting to a group A printer will execute the Login protocol using the class-specific commands defined in this specification. As a result of this protocol execution, the host will lock the printer and enable a transport protocol required by the host. From this point on until the host logs out, the printer can be interfaced with the transport protocol enabled.

Group B :”Direct-Print” Capable Printer

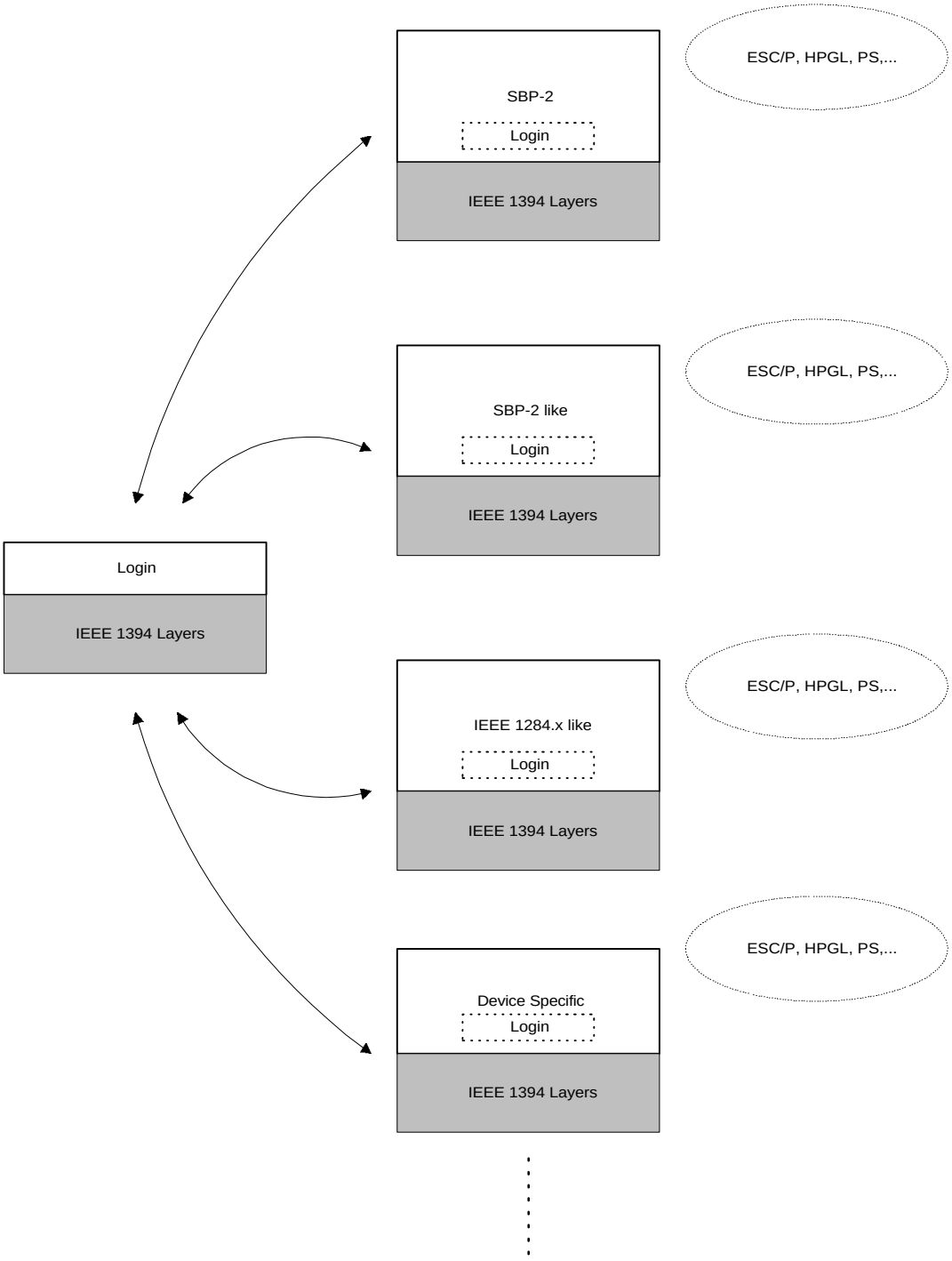
A host connecting to a group B printer will execute the Login protocol using the class-specific commands defined in this specification. As a result of this protocol execution, the host can enable the Direct-Print Protocol mode. From this point on until the host logs out, the printer can be interfaced with the Direct-Print Protocol.

Group C :Non-Login / “Direct-Print” Capable Printer

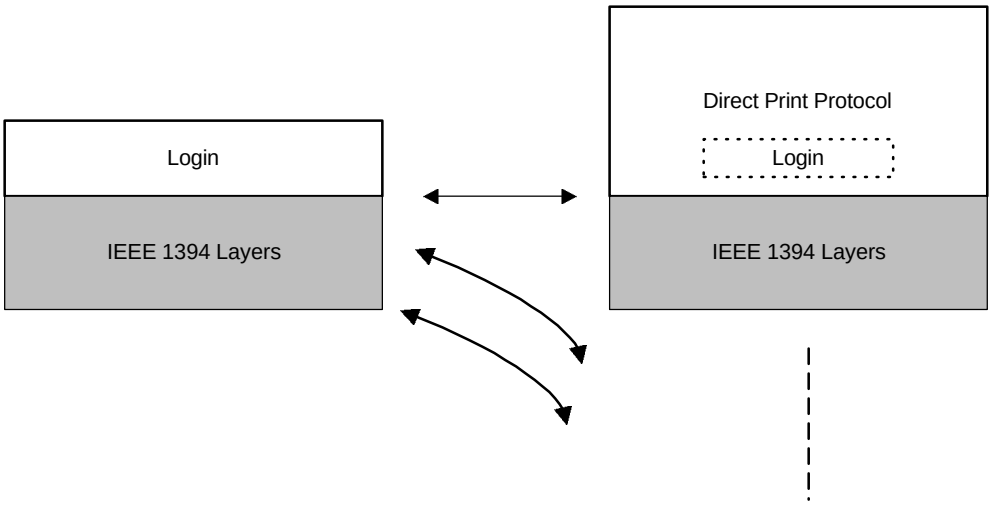
A function model will not be defined for group C printer connection and print sequences. The function model will be fully device(vendor) specific.

The following figures show the different printer groups and their functional overview.

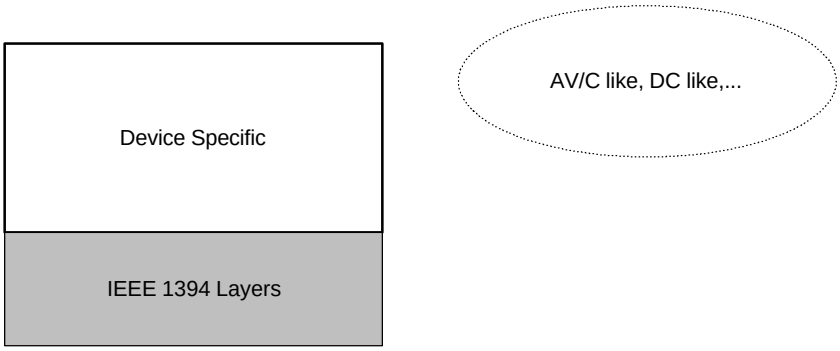
Group A


Login
IEEE 1394 Layers
SBP-2
Login
IEEE 1394 Layers
ESC/P, HPGL, PS,...
SBP-2 like
Login
IEEE 1394 Layers
ESC/P, HPGL, PS,...
IEEE 1284.x like
Login
IEEE 1394 Layers
ESC/P, HPGL, PS,...
Device Specific
Login
IEEE 1394 Layers
ESC/P, HPGL, PS,...

Group B



Group C



5. FUNCTIONAL CHARACTERISTICS

This section will describe the following functional characteristics of the Group A and Group B IEEE1394 printers.

- The operational model
- Interfaces

5.1. Group A - “Login Protocol” Capable Printer

5.1.1 Operational Model

The printer will support the Login Protocol and one or more transport protocol. The Login Protocol is defined in this document, and the transport protocol may take the form of transport protocols such as 1284.X, SBP-2, or something device specific. Commands that are used in the Login Process which will control the connection between the host and the printer, and those that are used in the transport protocol which will control transfer of print command and data.
A typical printing function using these commands takes the following sequence.

1. Any device can get current connection / printer status without locking on at anytime.
2. Host will inquire the current status which includes lock status and current transport protocol.
3. Host will lock on to the printer
4. Host will inquire transport protocol capabilities (What protocol is supported)
5. Host will enable the transport protocol mode that matches the capabilities of both the host and the printer.
6. Host / Printer will execute print job according to the enabled transport protocol.
7. Host will unlock from the printer, and reset modes enabled after the host has completed the printing task using a enabled transport protocol.

Of the above, steps 1,2,3,4 and 5 use the Login Protocol commands. Step 6 will reside on the transport protocol. Multiple login is possible if the transport protocol selected support the feature.
The transport protocol commands will control the actual printing sequence after the printer has made connection with the host using the Login Protocols noted above.

The transport protocol selected will control the data transfer. The usage of the protocols will reside on each protocol standard, and is undefined in this document.

5.1.2 Interface

Printers will at least support asynchronous bi-directional interfaces that will be used for the Login Protocol.

5.2. Group B :"Direct-Print" Capable Printer

5.2.1 Operational Model

The printer will support the Login Protocol and the Direct-Print Protocol. Both the Login Protocol and the Direct-Print Protocol are defined in this document. Commands that are used in the Login Process which will control the connection between the host and the printer, and those that are used in the Direct-Print Protocol which will control transfer of print command and data.
A typical printing function using the Direct-Print Protocol takes the following sequence.

1. Any device can get current connection / printer status without locking on at anytime.
2. Host will inquire the current status which includes lock status and current transport protocol.
3. Host will lock on to the printer
4. Host will inquire transport protocol capabilities (What protocol is supported)
5. Host will enable the Direct-Print Protocol mode.
6. Host / Printer will execute print job according to the **Direct-Print Protocol**.
7. Host will unlock from the printer, and reset modes enabled after the host has completed the printing task using a enabled transport protocol.

The Login Protocol (steps 1,2,3,4,5,7) will be identical to the Login Protocol explained in Group A, except that the host will enable the Direct-Print Protocol for step 5.
For group B printers, the Direct-Print Protocol (DDP) will be used to control the actual print process.(step 6)
A typical printing function using DDP takes the following sequence.

TBD

1. Inquire the current status of the printer engine.
2. Initiate printer engine control.
3. Inquire supported data format.
4. set data format.
5. trigger print start.
6. transfer print data until print job ends.

   printer will:

   - receive print data
   - monitor data received (in print buffer)
   - control printing sequence according to buffer contents at printer's own pace.
7. Reset (disable) printer engine control.

5.2.2 Interface

Printers will at least support asynchronous bi-directional interfaces that will be used for the Login Protocol.

5.3. Group C :Non "Login / Direct-Print" Capable Printer

5.3.1 Operational Model

No specific protocol will be defined for group C printers.

5.3.2 Interface

No interface requirements will be defined for group C printers.

6. PACKET FORMATS

This section will define the formats for asynchronous transaction packets used in the Login Protocol and Direct-Print Protocol. There are 2 types of transaction packets involved.

- Asynchronous Command Packets
- Asynchronous Data Packets

6.1 Asynchronous Command Packet Format

The following IEEE1394 compliant format should be used for asynchronous command packets of the Login Protocol and the Direct-Print Protocol.

PRELIMINARY

0-7	8-15	16-23		24-31	
destination_ ID		tl	rt	tcode	pri
source_ID					
destination offset					
header_CRC					
COMMAND FRAME					
data_CRC					

6.2 Asynchronous Data Packet Format

The following IEEE1394 compliant format should be used for asynchronous data packets of the Login Protocol and the Direct-Print Protocol.

0-7	8-15	16-23		24-31	
destination_ ID		tl	rt	tcode	pri
source_ID					
destination offset					
header_CRC					
DATA FRAME					
data_CRC					

7. LOGIN PROTOCOL

This section will explain the Login protocol.
Group A and group B compliant printers will support Login commands and response.
Hosts connecting to these printers will initiate the login sequence.
The login sequence will provide 2 main functions:
1. Standard means to lock on the printer and switch transport protocols.
2. Standard means to get information on basic status of the printer.

TBD

7.1 Login Commands / Response

Every Login protocol transaction will consist of

- one command
- one response

There are basically 3 commands(and response) involved in the Login Protocol;

- INQUIRE_LOCK
- LOCK_UNLOCK
- INQUIRE_STATUS

INQUIRE_LOCK

This command will inquire the current lock status and the transport protocol capability of the target printer. It will inform the printer the address which the printer should respond to.

0-7	8-15	16-23	24-31
CR	CMD	INITnodeID	
response offset			

Field	Bit	Description
CR	[0...7]	packet type 0 : COMMAND others: reserved
CMD	[8...15]	command type 0 : LOCK_INQUIRY

		others: reserved
INITnodeID	[16...31]	nodeID of initiator
response offset	[0...31]	offset for response packets

The response will inform

- Current status information will consist of lock status and current transport protocol mode. A locked state will mean that the printer is being controlled by one or more (depending on the protocol) hosts.
- Transport protocol capabilities will show what transport protocol is supported by this printer

0-7	8-15	16-23	24-31
CR	CMD	TARnodeID	
LOCK_STT		MULTI	PTCL_STT
CAPA			
VSCAPA			

Field	Bit	Description
CR	[0...7]	packet type 8 : RESPONSE/not implemented 9 : RESPONSE/accepted 10 : RESPONSE/rejected 11 : RESPONSE/in transition others: reserved
CMD	[8...15]	command type 0 : LOCK_INQUIRY others: reserved
TARnodeID	[16...31]	nodeID of target(printer)
LOCK_STT	[0...15]	Current Lock status of device. 255: Locking prohibited. 0: Unlocked 1: 1 host Locked

		2: 2 hosts Locked n: n hosts Locked
MULTI	[16]	Multi-loginCapability 0: Multi-login non-Capable 1: Multi-login Capable
PTCL_STT	[17]	vendor specific(1:current mode)
	[18]	Direct-Print Protocol(1:current mode)
	[19]	SBP2(1:current mode)
	[20]	1284.4(1:current mode)
	[21-31]	reserved

The CAPA field informs the supported transport protocol.

Field	Bit	Description (0:no support 1:support)
CAPA	[17]	vendor specific (refer to protocol list.)
	[18]	Direct-Print Protocol
	[19]	SBP2
	[20]	1284.4
	[21..31]	reserved

In case a vendor specific protocol is supported, the protocol type is informed in the VSCAPA field in ASCII.

Field	Bit	Description
VSCAPA	[0..31]	vendor specific protocol in ASCII

LOCK_UNLOCK

This command will control the lock status of the host and target printer. It will also set the transport protocol of the target printer.

It will be a rule for a initiator to make sure that it will unlock from the printer when it finishes it's print job.

0-7	8-15	16-23	24-31
CR	CMD	INIT node ID	
lock_login		0	
LOCK		0	
PROTO VS			

Field	Bit	Description
CR	[0...7]	packet type 0 : COMMAND others: reserved
CMD	[8...15]	command type 1 : LOCK 2 : UNLOCK others: reserved
INITnodeID	[16...31]	nodeID of initiator
LOCK	[0...15]	Set Lock status of device. 0 : SOFT_RESET 1 : LOCK(1st host) 2 : LOCK(2nd host) n : LOCK(nth host) 255: Don't use * Bits [1..15] is optional for printers not supporting multi-login.
	[16...31]	Don't use ("0")

LOCK(connect)
This command will enable the printer to make a transition to the Locked state. A locked state status will mean that the printer is being reserved for control by one or more (depending on the protocol) hosts.
When issuing this command, the host should first read the current printer status via INQUIRE_LOGIN, increment the LOCK_STT value by 1 and set the value as the parameter of the LOCK field.

SOFT RESET(disconnect)
This command will enable the printer to be in the Unlocked state, and reset all modes enabled by any hosts during the locked state.

1. The host must read the current lock status via GET_STATUS to check the number of locked hosts, and set the value as the parameter of the LOCK field.
2. When executing the reset upon receiving the SOFT_RESET request, the printer must first confirm that there is only one host left locked on to the printer.

The CAPA field will enable the transport protocol mode of the printer that will be given by the parameter. The host should assume that the printer will make a transition to the transport protocol after this command is issued.

Field	Bit	Description (0:disable 1:enable)
CAPA	[17]	vendor specific (refer to protocol list.)
	[18]	Direct-Print Protocol
	[19]	SBP2
	[20]	1284.4
	[21..31]	reserved

The PROTO field will set the vendor specific transport protocol if bit17 of SET_CAPA is 1.

Field	Bit	Description
VS	[0..31]	vendor specific protocol in ASCII

The response will inform

- Current status information will consist of lock status and current transport protocol mode.
- The Entry Offset of the set transport protocol.

RESPONSE FORMAT

0-7	8-15	16-23	24-31
CR	CMD	TARnodeID	
LOCK_STT		MULTI	PTCL_STT
VS			
ENTRY			

Field	Bit	Description
CR	[0...7]	packet type 8 : RESPONSE/not implemented 9 : RESPONSE/accepted 10 : RESPONSE/rejected 11 : RESPONSE/in transition others: reserved
CMD	[8...15]	command type 1 : LOCK 2 : UNLOCK others: reserved
TARnodeID	[16...32]	nodeID of target (Printer)
LOCK_STT	[0...15]	Current Lock status of device. 255: Locking prohibited. 0: Unlocked 1: 1 host Locked 2: 2 hosts Locked n: n hosts Locked
MULTI	[16]	Multi-loginCapability 0: Multi-login non-Capable 1: Multi-login Capable

PTCL_STT	[17]	vendor specific
	[18]	Direct-Print Protocol
	[19]	SBP2
	[20]	1284.4
	[21-31]	reserved

Field	Bit	Description
VS	[0..31]	vendor specific protocol in ASCII

The ENTRY field will return the entry for the transport protocol set .

Field	Bit	Description
ENTRY	[0..31]	offset for protocol entry.

INQUIRE_STATUS

This command will inquire the current status of the printer engine, and nodeIDs of nodes currently connected to the printer.

0-7	8-15	16-23	24-31
CR	CMD	INITnodeID	
response offset			

Field	Bit	Description
CR	[0...7]	packet type 0 : COMMAND others: reserved
CMD	[8...15]	command type 3 : STATUS_INQUIRY others: reserved
INITnodeID	[16...31]	nodeID of initiator
response offset	[0...31]	offset for response packets

The response will inform

- Current printer engine status information will consist of:
  1: printer engine status, online/ offline status, power management.
  2: nodeID(s) of node(s) connected to the printer.

RESPONSE FORMAT

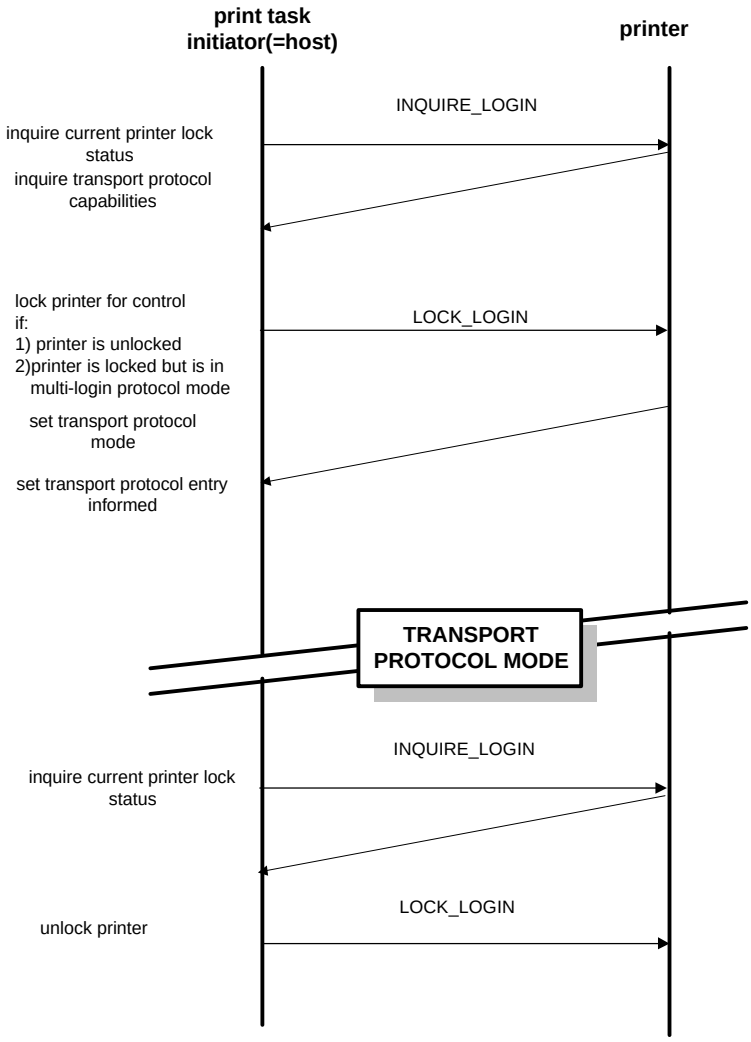
0-7	8-15	16-23	24-31
CR	CMD	TARnodeID	
STATUS	PWR	0	
0		connectNodeID1	
.....			
connectNodeID(n-1)		connectNodeIDn	

Field	Bit	Description
CR	[0...7]	packet type 8 : RESPONSE/not implemented 9 : RESPONSE/accepted

		10 : RESPONSE/rejected 11 : RESPONSE/in transition others: reserved
CMD	[8...15]	command type 3 : STATUS_INQUIRY others: reserved
TARnodeID	[16...32]	nodeID of target(printer)
STATUS /ENGINE	[0..1]	Status of printer engine 0: engine RESET 1: engine ready 2: engine initializing 3: engine error other: Reserved
STATUS/ ONLINE	[2..5]	Status of printer engine 0: OFF line 1: ON line 2: PRINT_RESET other: Reserved
STATUS/ PRINT	[6..7]	Print status 0: ready (no jobs running) 1: printing 2: print error other: Reserved
POWER	TBD	TBD
connectNodeID n	[0..15] [16..31]	nodeID of initiators currently connected to the printer.

7.2 Login Sequence

A typical login sequence flow will be shown below.



7.3 Bus Reset - Reconnection

There are no Login protocol reconnection functions for re-establishing connection after a 1394 bus reset. In other words, the transport protocol in progress when bus-reset occurs will be responsible for reconnection after bus reset is cleared.
Naturally ,
transport protocol candidates switched from the login protocol require support for reconnection functions in the case of a 1394 bus reset.

Bus Reset - Reconnection Requirements
Values of the fields included in response packets of INQUIRE_LOCK, and the connectNodeID field of the response packet of INQUIRE_STATUS

1. shall not change during bus reset
2. shall be updated by the device upon reconnection with a time limit of 1sec after bus-reset is cleared. Methods of updating are beyond the scope of the proposal. (Feedback from the reconnection function of the transport protocol in progress would be a reasonable method.)

8. DIRECT- PRINT PROTOCOL

This section will define the Direct-Print Protocol, and provide information needed to for a printing job to take place using this protocol.

DETAILS OF THIS SECTION IS CURRENTLY PROVIDED AS A SEPARATE DOCUMENT

This section will define the Direct-Print Protocol, and provide information needed to for a printing job to take place using this protocol.
This protocol will define;

- print data format
- printer control commands / requests

This document will also describe a typical printing process for use as a function model.

8.1 BACKGROUND

Hosts which will use the Direct-Print Protocol for printing directly will likely be input devices such as :

1. Computer peripheral devices such as Image scanners and Digital cameras, Conferencing cameras etc.

   The majority of these devices usually handle graphic data in the form of RGB, or JPEG format. The output of these devices are mostly still pictures, but outputs of devices such as Conferencing cameras are moving pictures. Currently, there are no standard means for these devices to directly control the printer to perform a print task.

2. Consumer AV/C electronic devices such as video camcorders, TVs etc.

   The data of these devices are closely in conjunction with the NTSC / PAL standards. Naturally, video data formats such as the DV format (and the DIF format used in the IEEE1394 AV/C protocol) are derived from these standards; YUV. Since raw data will be large in size, normal output data (data stored in tape, DIF data)will be compressed in a complex manner. Another characteristic of this category is that the base output of these devices are moving pictures.

Currently, there are no standard means for these devices to directly control the printer to perform a print task.

The DPP print data format designated in the Direct-Print Protocol (DPP) will be easy to implement both from the printer side and host side. The data packet format, and data packet transfer methods will also be easy to implement with little expansion to the system.
The remaining part of the DPP, the printer control protocol will present a solution for any device to easily control a DPP-capable printer .

DETAILS OF THIS SECTION IS CURRENTLY PROVIDED AS A SEPARATE DOCUMENT

9. IEEE 1394 SPECIFIC ADDRESS SPACE

The IEEE1394 printer compliant with this specification should be compliant with IEEE1394 and IEEE1212 standards. This section will describe the CSR and Configuration ROM locations that the printer will implement. All locations are intended to comply with the IEEE1394 standard.

Address Locations noted in this section are with respect to a base address of:

FFFF F000 0000h

9.1 CSR

The printer will implement the following CSR's, as required by the IEEE 1394 standard. :

CORE CSRs

offset	0-7	8-15	16-23	24-31
0000h	STATE_CLEAR			
0004h	STATE_SET			
0008h	NODE_IDS			
000Ch	RESET_START			
0010h				
0014h				
0018h	SPLIT_TIMEOUT_HI			
001Ch	SPLIT_TIMEOUT_LO			

SERIAL BUS DEPENDENT CSRs

offset	0-7	8-15	16-23	24-31
0200h	CYCLE_TIME			
0204h				
0208h				
020Ch				
0210h	BUSY_TIMEOUT			

9.2 CONFIGURATION ROM

TBD

The printer will implement the following CONFIGURATION ROM

BUS INFORMATION BLOCK

offset	0-7	8-15	16-23	24-31
0400h	04h	crc_length	rom_crc_value	
0404h	31h	33h	39h	34h
0408h	**** rsv	FFh	****	rsv
040Ch	node_vendor_id			chip_id_hi
0410h	chip_id_lo			

ROOT DIRECTORY

offset	0-7	8-15	16-23	24-31
0414h	0004h		CRC	
0418h	03h	module_vendor_id		
041Ch	0Ch	node_capabilities		
0420h	8Dh	node_unique_id_leaf_offset		
0424h	D1h	unit_directory_offset		

NODE UNIQUE ID LEAF

offset	0-7	8-15	16-23	24-31
0000h	0002h		CRC	
0004h	node_vendor_id			chip_id_hi
0008h	chip_id_lo			

UNIT DIRECTORY

offset	0-7	8-15	16-23	24-31
0000h	0003h		CRC	
0004h	12h	unit_spec_id **(TBD)**		
0008h	13h	unit_sw_version **(TBD)**		
000Ch	78h	Login Protocol entry_offset		

UNIT DEPENDENT DIRECTORY

offset	0-7	8-15	16-23	24-31
0000h	0003h		CRC	
0004h	40h	command_register base		
0008h	81h	vendor_name_leaf		
000Ch	82h	model_name_leaf		